Zeitschrift: Schweizer Archiv für Tierheilkunde SAT : die Fachzeitschrift für Tierärztinnen und Tierärzte = Archives Suisses de Médecine Vétérinaire ASMV : la revue professionnelle des vétérinaires

Herausgeber: Gesellschaft Schweizer Tierärztinnen und Tierärzte

Band: 136 (1994)

Heft: 6-7

Artikel: Ultrasonography of the umbilicus in calves, part 2. Ultrasonography, diagnosis and treatment of umbilical diseases

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DOI: https://doi.org/10.5169/seals-591398

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Ultrasonography of the umbilicus in calves. Part 2: Ultrasonography, diagnosis and treatment of umbilical diseases

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Summary

In 80 calves presented with cilinical signs of umbilical disease, the umbilicus was examined by palpation and by ultrasonography using a 5 Mhz or a 7.5 Mhz sector scanner. Diagnosis was confirmed during surgery or at post mortem examination. The various diseases of the intraabdominal umbilical structures found in theses calves and the therapeutic procedures performed are described in detail by use of schematic representations, photographs of anatomical preparations, and ultrasonograms.

In 29 calves with an enlarged extraabdominal umbilicus, ultrasonographic examination provided additional information to determine the choice of therapy, and it was particularly helpful in calves with irreducible hernias and with umbilical abscesses.

In 51 calves with diseases of the intraabdominal umbilical structures, an exact description of the extent of the disease and of the involvement of other structures, as the liver and the urinary bladder, was made possible by ultrasonography. In calves with omphalitis, early recognition of the involvement of intraabdominal umbilical structures could be determined.

Umbilical ultrasonography can be performed easily and is a very reliable and informative aid not only in the diagnosis of umbilical disease but also in determing the choice of therapy. Additionally, the owner can be informed in advance about the expense and the prognosis of the planned therapy.

Keywords: **calf – ultrasound – umbilicus – hernia – diagnosis – therapy**

Ultraschall des Nabels beim Kalb. Teil 2: Sonographische Befunde, Diagnose und Therapie von Nabelerkrankungen

Achtzig Kälber, die klinische Anzeichen einer Nabelerkrankung zeigten, wurden palpatorisch und sonographisch mit einem 5 Mhz- bzw. 7,5-Mhz-Sektorscanner untersucht. Die mittels Ultraschall gestellte Diagnose wurde in der Operation oder nach der Euthanasie überprüft. Anhand von schematischen Zeichnungen, anatomischen Präparaten und Ultraschallbildern werden die verschiedenen Erscheinungsformen der intraabdominalen Nabelentzündungen und ihre Therapie ausführlich erläutert.

Bei extraabdominalen Umfangsvermehrungen (29 Kälber) lieferte die Ultraschalluntersuchung vor allem bei nicht reponierbaren Hernien und bei Nabelabszessen zusätzliche Information für die Therapiewahl.

Besonders wertvoll war die Ultrasonographie für die Darstellung der intraabdominalen Nabelstrukturen. Bei Kälbern mit Omphalitis konnte eine Beteiligung des intraabdominalen Nabels frühzeitig erkannt oder ausgeschlossen werden.

Bei intraabdominalen Nabelentzündungen (51 Kälber) ermöglichte die Sonographie eine genaue Beschreibung der Grösse und des Ausmasses der veränderten Strukturen. Insbesondere konnte eine Beteiligung der Leber bzw. der Harnblase vor der Operation erkannt werden.

Die Sonographie erwies sich bei der Diagnose von Nabelerkrankungen als eine einfache und aussagekräftige Zusatzuntersuchung mit sehr grosser diagnostischer Sicherheit, was die Therapiewahl erleichterte. Ausserdem konnte der Besitzer zum voraus zuverlässig über Erfolgsaussichten und Kosten einer Nabeloperation informiert werden.

Schlüsselwörter: **Kalb – Ultraschall – Nabel – Hernie – Diagnose – Therapie**

Introduction

During the first few days of life, the umbilicus is a potential route of entry for pathogens. The umbilical involution should, therefore, proceed as rapidly as possible. Various factors delay and impair umbilical involution: inadequate sanitation at birth, partial failure of passive antibody transfer, weakness of the neonate, poor husbandry, and genetic predisposition (*Dirksen,* 1978). Impaired involution of the umbilicus may result in hematoma, herniation, or inflammation.

Umbilical hematoma emerges from inadequate closure of the umbilical vasculature after separation of the umbilical cord at birth. Umbilical hematoma increases the risk of infection; however, it rarely occurs in calves.

Umbilical hernias result from inadequate closure of the internal umbilical ring and are one of the most common heritable abnormalities in calves (Priester et al., 1970). The incidence of umbilical hernias is higher in Holstein cattle than in other breeds (Hayes, 1974; Surborg, 1978). The mode of inheritance is not entirely clear (Gilman and Stringam, 1953; Angus and Young, 1972; Brem et al., 1985). Acquired umbilical hernias usually develop secondarily to an inflammatory umbilical disease (Dirksen, 1978).

Inflammation may be limited to the umbilicus (Omphalitis) leading to formation of an abscess or a fistula. Omphalophlebitis, omphaloarteriitis, and/or omphalourachitis occur when internal umbilical structures are affected. Patent urachus is the term used to describe the condition in which the urachus fails to obliterate at birth, and urine is partially or totally discharged through the umbilicus via the urachus; the cause may be a congenital defect or an infection (Hunt and Allen, 1988; Hylton and Trent, 1989). Umbilical diseases occur either separately or in various combinations.

Identification of the extent of an infectious process represents a major goal of the umbilical examination. Ultrasonography is an ideal diagnostic aid in visualizing the umbilical structures in calves (Craig et al., 1986; Steiner et al., 1988; 1990; Lischer, 1991; Lischer and Steiner, 1993). The purpose of this study was to determine the diagnostic potential of ultrasonography in the diagnosis of umbilical disease in calves. The surgical and post mortem findings were used to determine the reliability of the ultrasonographic diagnosis.

Animals, material and methods

Animals

Eighty calves were used in this study; all had been referred to the Clinic of Large Animal Surgery, University of Zürich during 1990 because of an umbilical disease. Of the 80 calves, 54 were Swiss Braunvieh, 11 were Swiss Holstein, 14 were Simmental, and 1 was an Angus. At the time of referral, 23 calves were less than 3 weeks old, 24 were between 3 and 6 weeks old, and 30 were between 6 weeks and 6 months old. Three calves were older than 6 months.

Clinical examination

All calves underwent a thorough clinical examination; special consideration was given to organ systems with possible pyemic involvement (joints, lungs) and to micturition. Adspection (criteria: shape, size, color, possible fistulae, and nature of discharge), palpation (criteria: consistency, heat, pain, reducibility of contents, and detection of internal umbilical ring), and in some cases, centesis of the extraabdominal umbilicus were performed. Fistulous tracts were not probed because of the risk of abdominal perforation and consecutive spreading of pathogens. Examination of the intraabdominal umbilical structures was performed by careful bimanual palpation of the abdomen cranial and caudal to the umbilicus. In calves with tense abdominal wall, palpation was performed after sedation with xylazine[1] (0.1 mg/kg bw, im) (Trent, 1987).

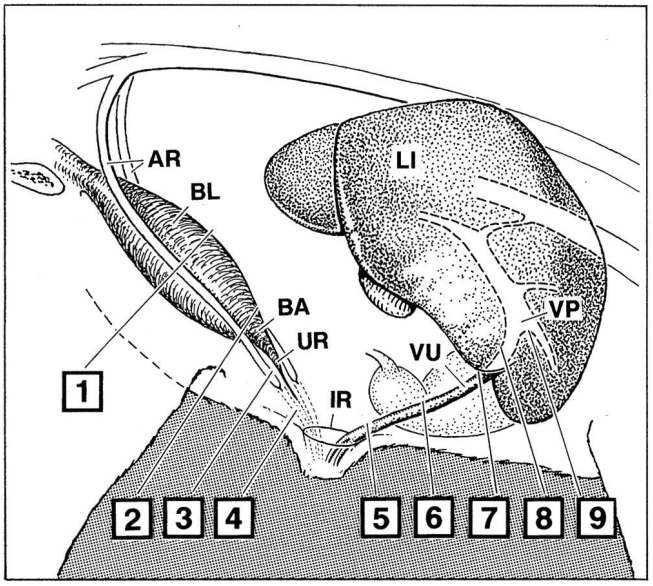
Ultrasonographic examination

A 20 cm wide area of the ventral abdomen ranging from the xyphoid to the pelvis was clipped and the calves were examined using a portable ultrasound machine (Microimager 1000[2]) equipped with two sector scanners: a 5 Mhz and a 7.5 Mhz with a stand off pad. A standardized technique of the ultrasonographic examination was used (Lischer, 1991; Lischer and Steiner, 1993). The cross-sectional and longitudinal diameters of the umbilical structures and the respective distance to the abdominal wall were measured at 9 defined positions (fig. 1). The thickness of the wall of the umbilical vasculature or the urachus was measured when the lumen could be identified on the ultrasonogram. The previously described results of ultrasonography of umbilical involution in healthy calves were used as a reference in this study (Lischer, 1991; Lischer and Steiner, 1993).

The ultrasonographic diagnosis was confirmed during surgery or at post mortem examination. Calves that were euthanatized because of poor prognosis were frozen at -20 °C; three days later, these calves were cut in the transversal plane at the 9 positions described in figure 1. Umbilical structures resected at surgery were placed in a water bath and examined via ultrasonography; subsequently, these structures were cut in cross-sections at the positions that had been examined ultrasonographically allowing to compare the ultrasonographic image with the anatomical preparation.

[1] Rompun, Bayer Leverkusen, Provet AG, CH-3421 Lyssach
[2] Sonoscan SA, route de la Glâne 43b, 1752 Villars sur Glâne

Figure 1: Positions for ultrasonographic examination of the intraabdominal umbilical structures.



The umbilical arteries (AR) are imaged alongside the urinary bladder (BL) (position 1) and near the apex of the bladder (BA) (position 2). The urachus (UR) and the umbilical arteries are imaged approximately half way between the bladder and the inner umbilical ring (IR) (position 3) and directly caudal to the inner umbilical ring (position 4). The umbilical vein (VU) is visualized immediately cranial to the inner umbilical ring (position 5), half way between the inner umbilical ring and the liver (LI) (position 6), at the caudoventral margin of the liver (position 7), and at the level of the venous sulcus of the liver (position 8). At position 9, the junction of the umbilical vein with the left branch of the portal vein (VP) can be imaged.

Therapy

The therapeutical procedures performed at the Clinic of Large Animal Surgery, University of Zürich and their respective indications are summarized and briefly described in table 4. All surgical procedures that did not involve a laparotomy (tab. 3) were performed on recumbent calves sedated with Xylazine[1] (0.2 mg/kg body weight, intramuscularly) and under local anesthesia (lignocaine with hyaluronidase[3]). Laparotomies were performed with the calves in dorsal recumbency and anesthetized with nitrous oxide, halothane and oxygen (tab. 4).

[3] Lidocain-Hyaluronidase 2%, G. Streuli & Co. AG, CH-8730 Uznach

Results

Umbilical hernia

Clinical examination

Umbilical hernia was diagnosed by palpation in 13 (87%) out of 15 calves (tab.1). The criteria used for the diagnosis were complete reducibility of the umbilical mass and ability to palpate the entire inner umbilical ring. In 2 calves, the umbilical hernia could not be reduced. The inner umbilical ring had a diameter of 0.5 cm in one of these calves; the hernial sac that was approximately 7 cm in diameter contained only abdominal fluid. In the other calf, poor general condition and an incarcerated umbilical hernia were diagnosed. Palpation of the navel was painful and the calf showed symptoms of a small intestinal obstruction. In both calves, umbilical abscess and hematoma were ruled-out by centesis of the umbilical mass.

Ultrasonographic examination

Using the 7.5 Mhz transducer, the contents of the umbilical hernia could be identified ultrasonographically. Abdominal fluid was completely anechoic. Parts of the omentum located in the umbilical hernia appeared as disordered, hyperechoic, interconnected areas. Protruded parts of the abomasum could be identified based on its contents. Immediately after feeding milk, the contents of the abomasum featured hyperechoic foci in the ultrasonograms; a few hours later, the contents appeared mostly anechoic interspersed with mobile, hyperechoic clumps (curdled milk). Loops of small intestine (diameter = 15–25 mm), imaged in longitudinal- and cross-sections, could be identified because of their distinct contractions (figs. 3a, 4b, 4c). Wall and lumen of the small intestine could be distinguished clearly. In the calf with an incarcerated umbilical hernia, loops of dilated, non-mobile small intestine (maximum diameter = 35 mm) were imaged in the hernial sac and in the abdomen adjacent to the inner umbilical ring.

Table 1: Diagnoses of 80 calves with umbilical disease

Extraabdominal umbilicus	**29**
Hematoma	1
Hernia	15
Omphalitis	9
Omphalitis and hernia	4
Intraabdominal umbilicus	**51**
Urachitis	6
Arteriitis	4
Phlebitis	19
Urachitis and arteriitis	13
Phlebitis and urachiitis	2
Phlebitis and arteriitis	2
Phlebitis, arteriitis and urachitis	5
TOTAL	**80**

Table 2: Conservative therapy in calves with umbilical disease

THERAPY	DESCRIPTION	INDICATION
local therapy	clipping, washing, and disinfection of the umbilicus with polyvidone iodine solution (10%); ointment causing hyperemia (Berchtold et al., 1990)	acute omphalitis
parenteral antibiosis	penicillin[4], 24 000 IU/kg bw, im, daily for a minimum of 5 days (Klein and Firth, 1988)	acute omphalitis with fever above 40 °C; standard therapy after surgery
	oxytetracyclin[5], 64 mg/kg bw, iv, daily for a minimum of 5 days	acute omphalitis with bronchopneumonia
	enrofloxacinum[6], 2.5 mg/kg bw, sc, daily for 5 days	acute omphalitis with involvement of other organs

[4] Procain-Penicillin G, Pfizer AG, Flüelastrasse 7, CH-8048 Zürich
[5] Engemycin® 10%, Veterinaria AG, Grubenstrasse 40, CH-8045 Zürich
[6] Baytril® 10%, Bayer Leverkusen, Provet AG, CH-3421 Lyssach

Table 3: Surgical therapy without laparotomy in calves with umbilical disease

THERAPY	DESCRIPTION	INDICATION
lancing and drainage of abscess	percutaneous lancing of the abscess, introcuction of a latex drain, rinsing of the abscess cavity with diluted povidone iodine solution until discharge is free of purulent material (Aderibigbe, 1986)	extraabdominal abscesses, intraabdominal abscesses that have an extensive attachment to the abdominal wall
resection of an abscess in toto without laparotomy	skin incision, separation of skin from the capsule of the abscess and resection of the abscess in toto, primary closure of the incision (Dirksen, 1978)	thick-walled (thickness of capsule 1 cm) extraabdominal abscesses, less than 10 cm in diameter

Table 4: Surgical therapy with laparotomy in calves with umbilical disease

THERAPY	DESCRIPTION	INDICATION
herniorrhaphy	closure of the inner umbilical ring after resection of the hernial sac (Baxter, 1989)	hernia, hernia with omphalitis
resection of the intraabdominal umbilical structures (RIU)	complete surgical resection of the intraabdominal umbilical structures (Bouckaert and DeMoor, 1965; Cheli, 1968; Dirksen and Hofmann, 1976)	urachitis und omphaloarteriitis without involvement of the urinary bladder, omphalophlebitis without involvement of the liver
RIU with resection of the apex of the urinary bladder	additional resection of the apex of the urinary bladder (Baxter, 1989; Trent and Smith, 1984; Steiner et al., 1990)	urachitis und omphaloarteriitis with involvement of the urinary bladder
drainage with RIU	lancing and rinsing of the abscess several days preoperatively (advantage: subsequent surgery is easier and safer) (Trent, 1987; Steiner et al., 1990;)	abscesses larger than 10 cm in diameter with involvement of the intraabdominal umbilical structures
marsupialisation	vertical displacement of the pus-filled umbilical vein to the cranial end of the incision, rinsing of the umbilical vein, resection of the umbilical vein remnant in a second operation, 1 to 2 month later (Bouckaert and DeMoor, 1965; Trent and Smith, 1984; Steiner et al., 1992)	purulent omphalophlebitis with involvement of the liver

Therapy

Herniorrhaphy was performed in all 15 calves. In the calf suffering from an incarcerated umbilical hernia, a small intestinal resection had to be performed.

Omphalitis

Clinical examination

Based on the clinical findings, extraabdominal omphalitis was diagnosed in 59 (74%) out of 80 calves. Ultrasonographic examination revealed that inflammation was

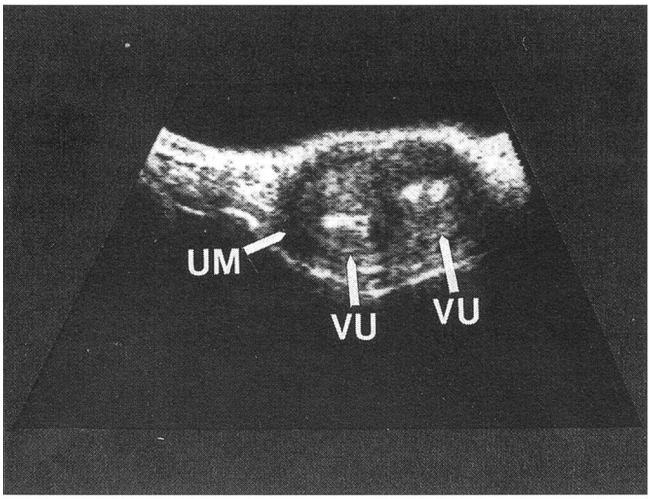
limited to the extraabdomial umbilicus in 13 calves (tab.1). Involvement of the intraabdominal umbilical structures could not be ruled-out by abdominal palpation in 8 (62%) of these 13 calves.

Acute omphalitis (22 calves) with fever was most frequently seen in calves less than 3 weeks of age. In these cases, the umbilicus was enlarged, extremely painful, and usually cylindrical in shape. Chronic, recurrent, fistulous omphalitis (28 calves) was the most common umbilical disease in calves older than 2 month. The owners of these calves observed recurrent, purulent discharge from the enlarged umbilicus even after conservative therapy had been performed. Umbilical abscesses were diagnosed in 9 calves by means of a centesis.

Ultrasonographic examination

The most important ultrasonographic criterion for diagnosis of omphalitis was the presence of an enlarged extraabdominal umbilicus (diameter >3 cm in the first three weeks of life and >2 cm after the third week of life) without involvement of the intraabdominal structures. In calves with acute omphalitis that were 3 weeks old or younger, the extraabdominal umbilicus was homogeneously hypoechoic in cross-section; if hyperechoic areas were seen additionally, a purulent omphalitis (fig. 2) was diagnosed. In these calves the 7.5 Mhz transducer

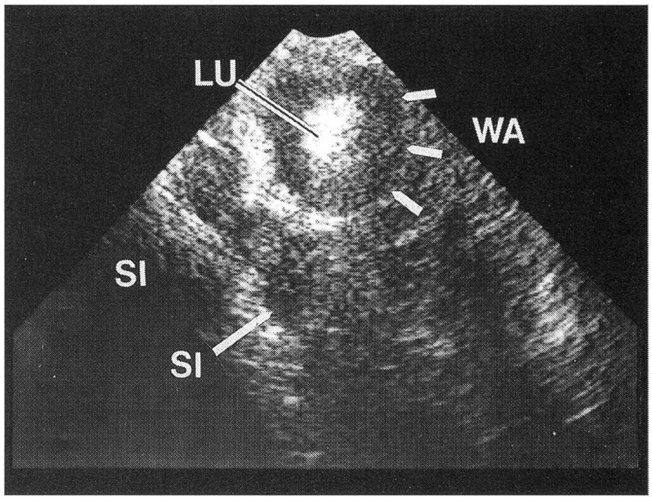
Figure 2: Acute, purulent omphalitis in a 3 week old calf.



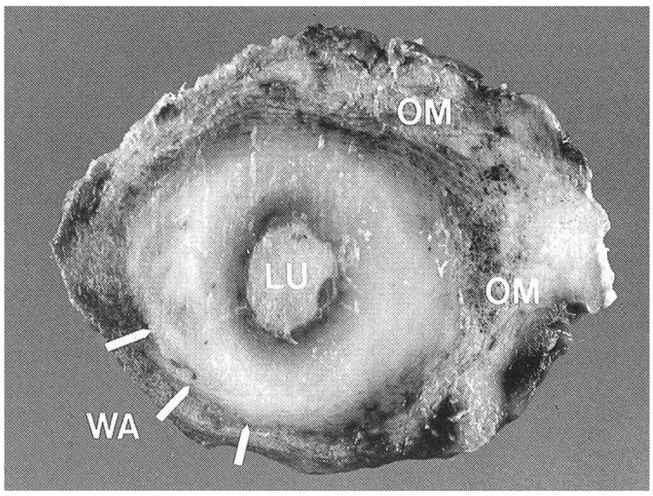
Ultrasonogram (cross-section; 7.5 Mhz scanner) of the base of the extraabdominal umbilicus (UM). The center of both stumps of the umbilical veins (VU) contains purulent material and appears hyperechogenic.

was used as first choice. Contents, diameter, width of cap-sule, and possible compartmentalization of umbilical abscesses were determined using the 5 Mhz transducer. The ultrasonographic appearance of the contents of umbilical abscesses varied: watery contents appeared as multiple, hyperechoic particles on an anechoic background (figs. 5b, c); pus of a creamy consistency appeared as multifocal, hyperechogenic particles interspersed with extremely hyperechogenic areas (fig. 8b); pus of a cheesy consistency often had a homogeneous echodensity (figs. 3b, 7b). The abscess-capsules were always more or less hypoechoic and varied in thickness from 0.5 to 3 cm. Umbilical abscesses that had an anechoic border of at least 5 mm in width between the capsule of the abscess and the skin and a capsular width of more than 1 cm were usually removed by blunt dissec-

Figure 3: Purulent umbilical vein in a 8 week old calf.



3a: Ultrasonogram (cross-section; position 5; 5 Mhz scanner) of the umbilical vein. The thickened umbilical vein (VU; outer diameter = 37 mm) has a homogeneously, hypoechogenic wall (WA; thickness = 9 mm). The lumen (diameter = 19 mm) appears homogeneously echogenic. Two cross-sections of empty loops of small intestine (SI) (diameter = 19 mm) can be observed beside the vein.

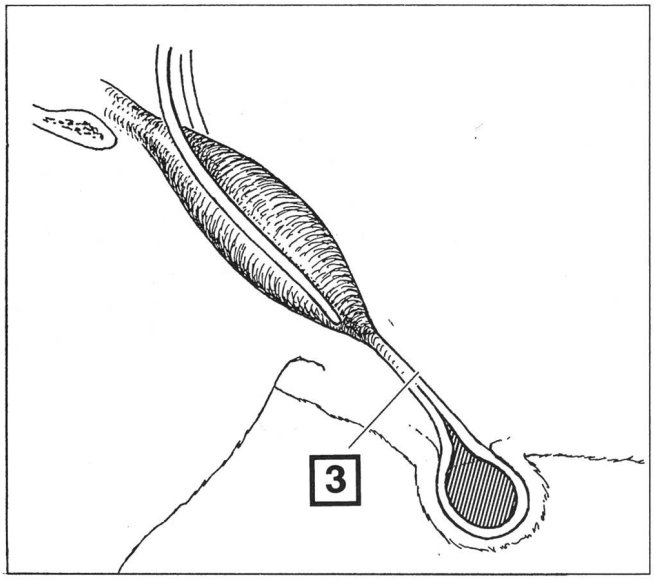


3b: Frozen section (cross-section; position 5) of the umbilical vein at the same site as figure 3a. The bright, thickened wall of the vein (WA) is surrounded by adhesions with the omentum (OM). The lumen (LU) contains cheese-like pus.

tion. Umbilical abscesses that had a capsule of less than 1 cm in width and were not clearly demarcated from the skin were lanced.

In calves younger than 3 weeks of age, involvement of intraabdominal umbilical structures was suspected when more than 2 vessels and in calves older than 3 weeks of age when any vascular structure were observed in cross-sectional ultrasonograms of the extraabdominal umbilicus. In 95% of the cases, the sonographic diagnosis was confirmed.

Figure 4: Urachal abscess without involvement of the urinary bladder in a 6 week old calf.



4a: Schematic representation

Therapy

5 of 13 calves with omphalitis were treated conservatively. Two umbilical abscesses were lanced and 2 were resected in toto. Excision of the affected umbilical remnant and subsequent herniorrhaphy were performed in 4 calves.

Inflammation of the intraabdominal umbilical structures

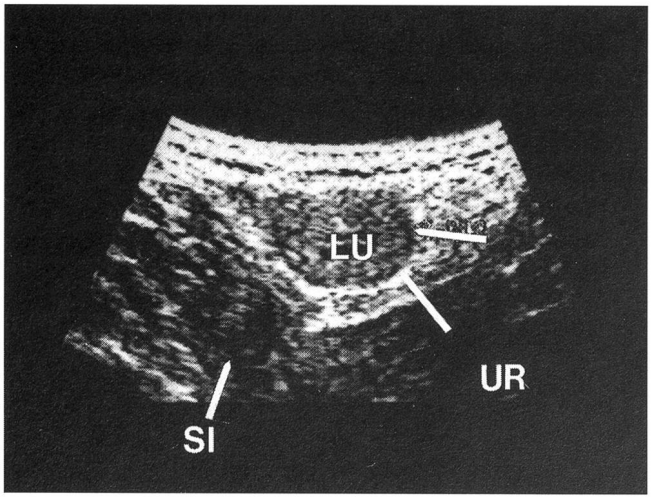
Clinical examination

49 (96%) of 51 calves with inflammation of the intraabdominal structures were presented because of an enlargement of the umbilicus. A tentative diagnosis of an infection of the intraabdominal umbilical structures was made in 43 cases (84%); it was based on the results of the abdominal palpation revealing intraabdominal structures running cranially or caudally from the umbilicus. Eight cases could not be diagnosed because either the calf was too large (6 cases) or the abdomen was so tense that the results of palpation were inconclusive (2 cases). In none of the cases, palpation allowed to identify the exact extent of the infection with certainty.

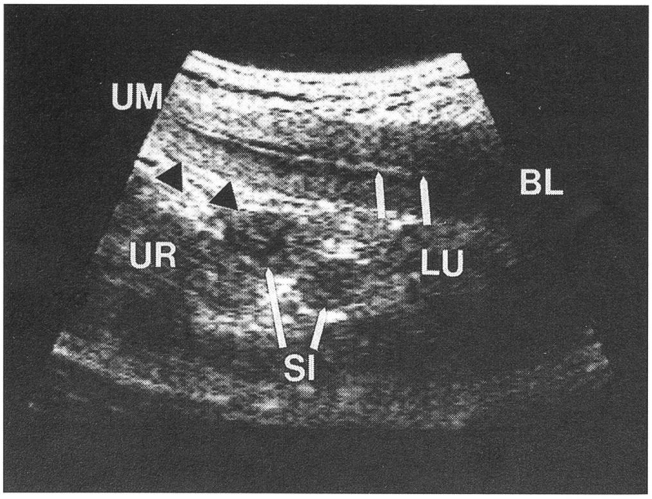
Of 29 calves with omphaloarteriitis and/or urachitis, 27 (93%) had pollakiuria and/or stranguria. In the other 2 calves with normal micturition, abscess formation of the urachus without involvement of the bladder was diagnosed ultrasonographically. In addition, dripping of urine from the umbilicus was observed in 2 calves.

Ultrasonographic examination

In comparison to reference values, inflamed umbilical structures were thicker, more homogeneously hypoechogenic, and could be more clearly imaged. Hyperechogenic material was also seen in the lumina of umbili-



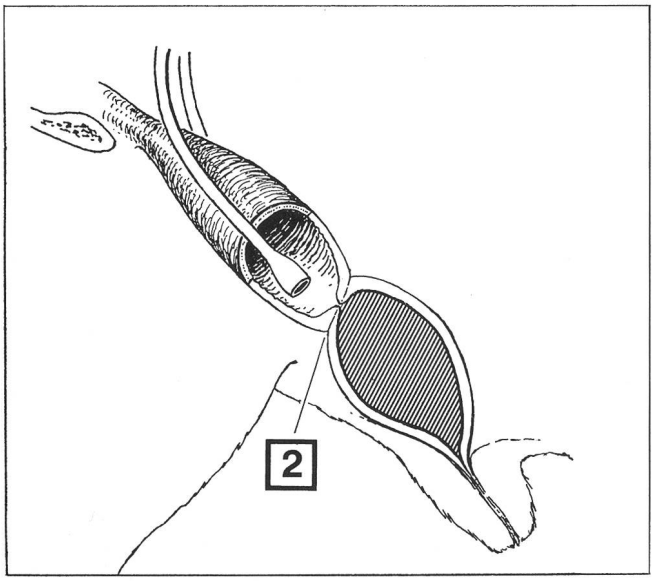
4b: Ultrasonogram (cross-section; position 3; 7.5 Mhz scanner) of the thickened urachus (UR) with hyperechogenic material in the Lumen (LU). Cross-sections of several empty loops of small intestine (SI) are seen beside the urachus.



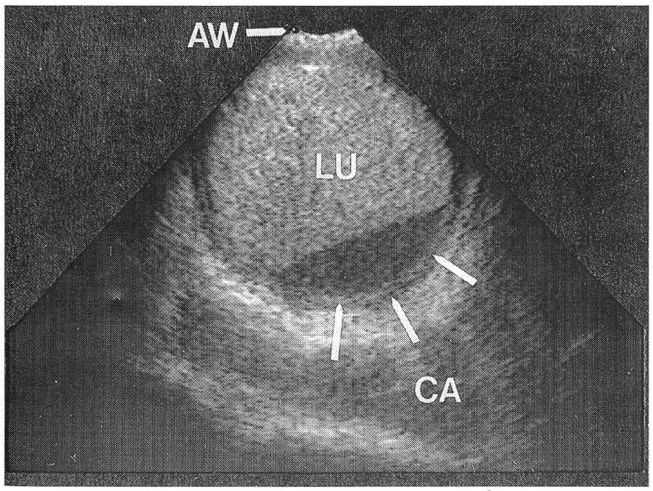
4c: Ultrasonogram (longitudinal-section; position 3; 7.5 Mhz scanner) of the thickened urachus (UR). The hyperechogenic material in the lumen (LU) does not reach the urinary bladder (BL). UM: Umbilicus, SI: small intestine

cal vessels in calves with purulent omphalitis (figs.3a, b). The thickness of the vessel walls of all umbilical structures with suppuration was between 0.7 and 3 cm. Exceptions to this were 5 calves, 3 weeks of age or younger, with acute, purulent omphalitis. In these calves, the intraabdominal umbilical structures, viewed in cross-sections, were not clearly demarcated and were heterogeneously hypoechogenic to hyperechogenic without clearly recognizable walls (fig.7d); during a second examination performed 2 weeks later, the same structures were clearer visible and better demarcated from the surrounding viscera (fig.7e).

Figure 5: Urachal abscess with involvement of the urinary bladder in a 3 month old calf.



5a: Schematic representation



5b: Ultrasonogram (cross-section; position 2; 5 Mhz scanner) of the urachal abscess. The border between the anechoic fluid and the hyperechogenic sediment is seen in the lumen (LU) of the abscess, which contains watery, purulent material. The capsule (CA) of the abscess is firmly adhesed to the abdominal wall (AW).

The exact extent to which the umbilical structures were affected could be determined via ultrasonography. The 7.5 Mhz transducer was used predominantly in calves younger than 6 weeks. In all cases, the ultrasonographic diagnosis, confirmed either at surgery or post mortem examination, was correct. The various ultrasonographic diag-noses of intraabdominal umbilical diseases are presented in table 5.

Urachal diseases

The diagnosis of urachitis was made when the urachus of calves older than 2 days had a diameter of more than 1 cm and could be clearly imaged between the umbilicus and the urinary bladder. Purulent urachitis was diagnosed when the lumen appeared hyperechogenic in ultrasonograms.

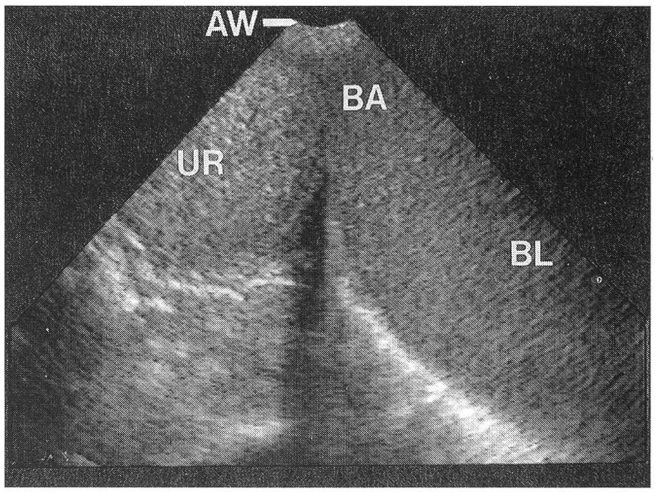
With regard to therapy, it was appropriate to divide diseases of the urachus into two groups based on the involvement of the urinary bladder.

Urachitis without involvement of the urinary bladder (fig.4):

Except for the 2 calves with normal micturition, a continuous connection between the umbilicus and urinary bladder was seen ultrasonographically. The urinary bladder always had a recognizable, anechoic lumen and a homogeneously hypoechogenic wall of uniform width. In longitudinal sections through the pole of the urinary bladder (position 2), the distance between the lumen of the bladder and the pusfilled, hyperechogenic lumen of the urachus was at least 3 cm (figs. 4b, c).

Urachitis with involvement of the urinary bladder (fig.5):

In cross-section, the urachus could not be clearly differentiated from the apex of the urinary bladder. In longitudinal-section, the bladder could be identified as a



5c: Ultrasonogram (longitudinal-section; position 2; 5-Mhz scanner) of the urachal abscess (UR) and the bladder apex (BA). There is a direct connection between the urachal abscess and the urinary bladder (BL).

tube-shaped structure with a small, anechoic lumen in 50% of the cases. The wall of the urinary bladder was thickened at the apex, and the pus-filled lumen of the urachus was very close (< 3 cm) to the anechoic lumen of the urinary bladder. In 2 calves, there was a direct communication between the abscess and the urinary bladder containing multifocal, hyperechoic particles (figs.5b, c).

The size of the involved structures was another criterion used to select the appropriate therapy. In 6 calves, the cross-sectional diameter of the urachus exceeded 10 cm; preoperative lancing and draining of the abscesses were indicated. In 2 calves, the abscesses were situated completely within the abdominal cavity. Ultrasonography revealed that the distance between the lumen of the abscess and the abdominal wall did not exceed 2 cm and there was no demarcation between the hypoechogenic capsule of the abscess and the abdominal wall. In these cases, it was possible to lance the abscess percutaneously under ultrasonographic guidance.

Patent urachus:

A not-purulent patent urachus was diagnosed in 2 calves both of which were less than 3 weeks of age and showed dripping of urine from the umbilicus. In cross-section, ultrasonography revealed a round, hypoechogenic structure with a diameter of 1.5 cm and with a small, anechoic lumen in the center. In longitudinal-section, a thin, anechoic connection between the lumen of the urinary bladder and the umbilicus was observed (fig. 6).

Omphaloarteriitis

Omphaloarteriitis was diagnosed when the diameter of an umbilical artery exceeded 15 mm. Between the urinary bladder and the umbilicus, an enlarged umbilical artery could not be distinguished ultrasonographically from an enlarged urachus. Therefore, omphaloarteriitis was only diagnosed when an enlarged umbilical artery was observed on one side of the urinary bladder. Urachitis and arteriitis often occurred together (18 calves; figs. 7a–e). As for urachitis, calves with omphaloarteriitis were divided into 2 groups based on the involvement of the urinary bladder. In 3 calves, an abscess of the umbilical artery limited to the region near the neck of the urinary bladder was diagnosed.

Omphalophlebitis

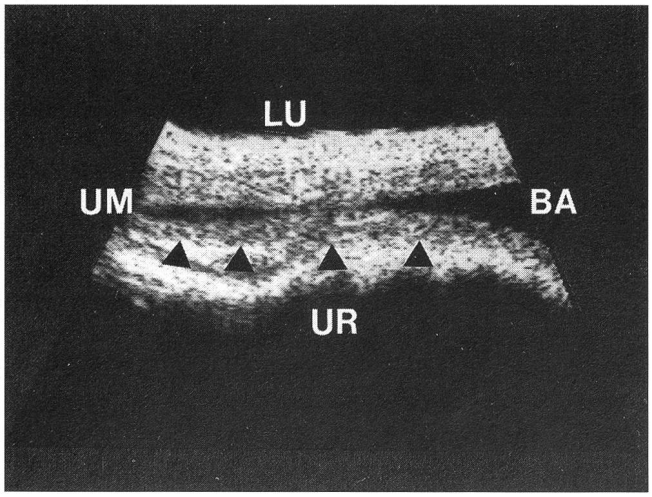
Omphalophlebitis was diagnosed in calves up to 3 week of age when the diameter of the umbilical vein was more than 2.5 cm and its lumen was not completely anechoic. In calves older than 3 weeks, omphalophlebitis was diagnosed when the umbilical vein could be clearly imaged running from the umbilicus to the liver and when its diameter exceeded 1.5 cm. In calves with purulent phlebitis, the lumen of the umbilical vein was hyperechogenic.

Involvement of the liver was determined by imaging the entrance of the umbilical vein into the sulcus venae umbilicalis at the caudoventral margin of the liver (position 7; cross- and longitudinal- section).

Omphalophlebitis without involvement of the liver (figs.8, 9):

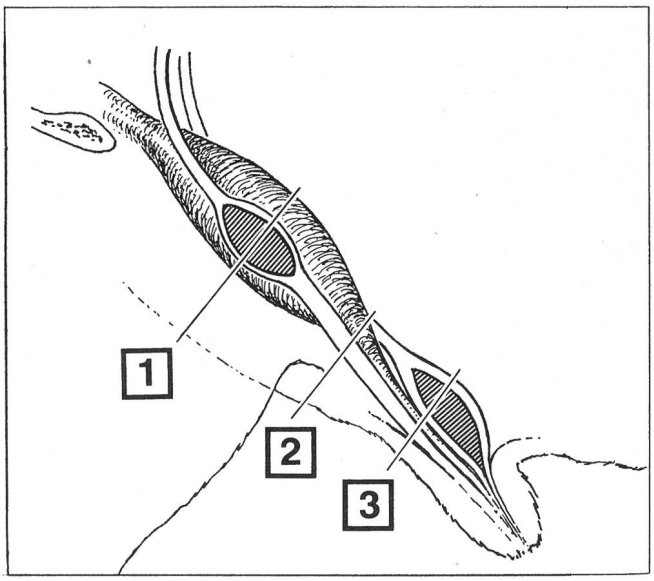
The enlarged umbilical vein running from the umbilicus to the caudoventral margin of the liver could be imaged ultrasonographically. However, if the pus-filled lumen of

Figure 6: Patent urachus in a 2 week old calf.

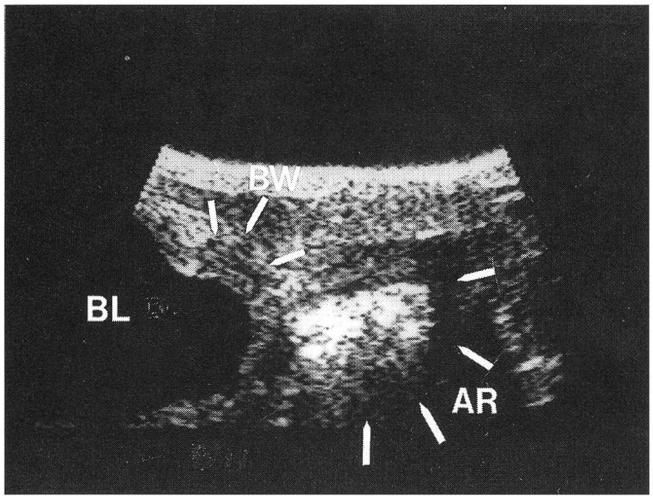


Ultrasonogram (longitudinal-section; position 2; 7.5-Mhz scanner) of the urachus (UR) at the level of the bladder apex (BA). The hypoechogenic wall of the urachus has a maximal thickness of 4 mm. The anechoic lumen (LU) can be visualized to the umbilicus (UM).

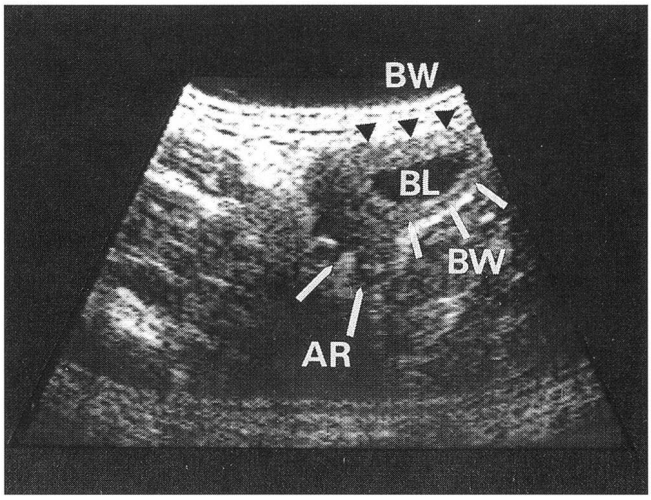
Figure 7: Various forms of omphaloarteritis with urachitis.



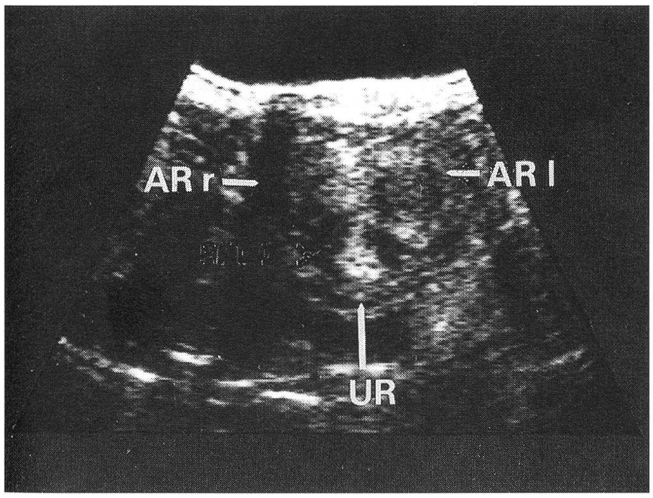
7a: Schematic representation of an abscess in the right umbilical artery (postition 1; b), an omphaloarteritis (position 2; c) and an abscess in the left umbilical artery and an urachitis (position 3; d, e).



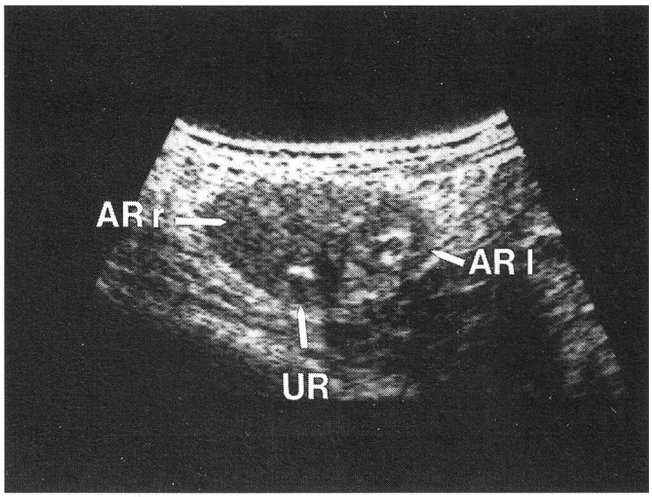
7b: Ultrasonogram (cross-section, position 1; 7.5 Mhz scanner) of an abscess in the right umbilical artery (AR) of a 5 week old calf.
The abscess alongside the urinary bladder (BL) contains creamy, heterogeneously hyperechogenic pus. The hypoechogenic wall of the bladder (BW) cannot be differentiated from the thin (5 mm) capsule of the abscess, via ultrasonography.



7c: Ultrasonogram (cross-section, position 2; 7.5 Mhz scanner) of the left umbilical artery of a 4 week old calf.
Although the lumen of the left umbilical artery (AR) does not contain pus, it is enlarged (diameter = 16 mm). The heterogeneously hypoechogenic wall of the umbilical artery is separated from the even wall (BW) of the urinary bladder (BL) by a small anechoic line.

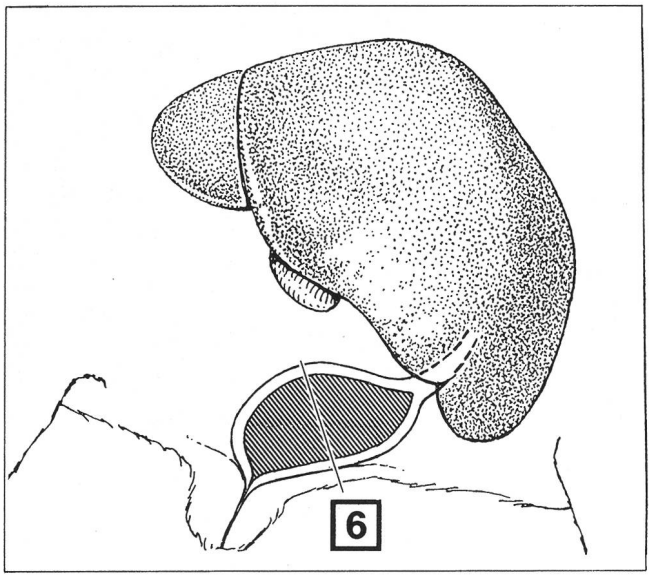


7d: Ultrasonogram (cross-section, position 3; 7.5 Mhz scanner) of the umbilical arteries and the urachus of a 2-week-old calf with acute omphalitis.
Both umbilical arteries (ARl, ARr) and the urachus (UR) are seen as circular, heterogeneous structures within the intraabdominal umbilicus (diameter = 43 mm) which is poorly demarcated from the exterior.

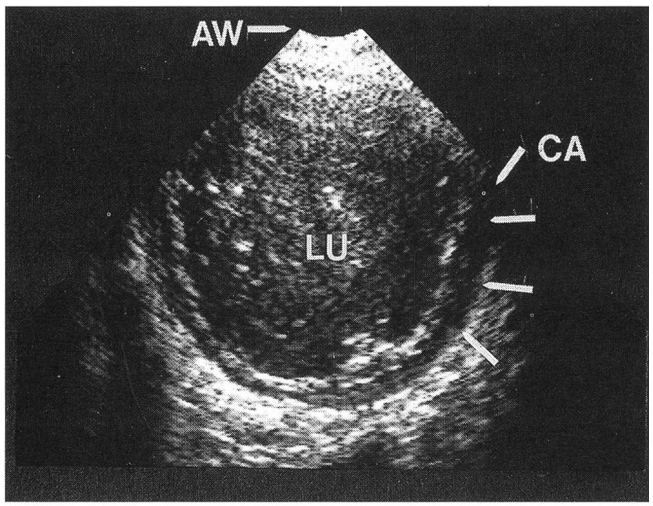


7e: Ultrasonogram (cross-section, position 3; 7.5 Mhz scanner) of the umbilical arteries and the urachus of the same calf as in figure 7d, but 2 weeks after conservative therapy had been initiated.
The intraabdominal umbilicus, which contains both umbilical arteries (AR) and the urachus (UR), is smaller (vertical diameter = 26 mm) and clearly demarcated from the exterior. The lumina of the left umbilical artery (ARl) and the urachus contain purulent, hyperechogenic material.

Figure 8: Abscess of the umbilical vein without involvement of the liver in a 3 month old calf.

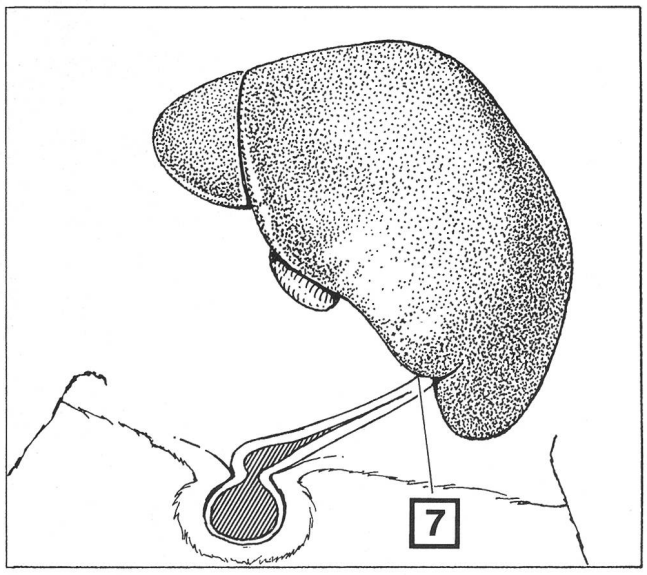


8a: schematic representation

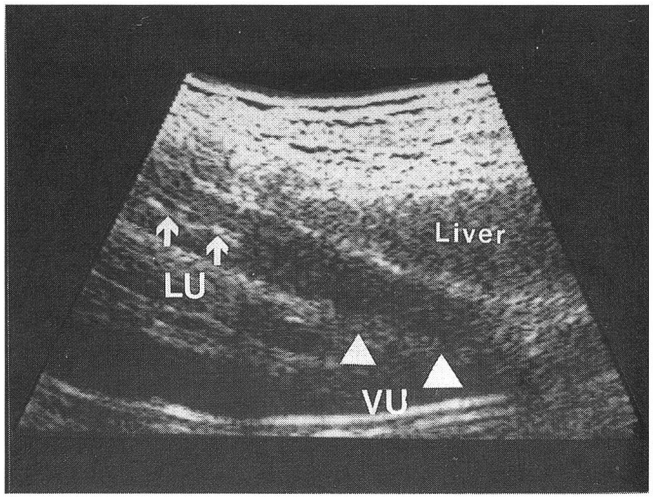


8b: Ultrasonogram (cross-section; position 6; 5 Mhz scanner) of the umbilical vein. The creamy pus in the lumen of the abscess (LU) appears hypoechogenic with multifocal, extremely hyperechogenic areas. The capsule of the abscess (CA) is very hypoechogenic and firmly adhesed to the hyperechogenic abdominal wall (AW).

Figure 9: Purulent omphalophlebitis without involvement of the liver in a 6 week old calf.



9a: Schematic representation



9b: Ultrasonogram (longitudinal-section; position 7; 7.5 Mhz scanner) of the umbilical vein. The small, hyperechogenic lumen (LU) of the umbilical vein (VU) reaches exactly to the level of the narrow-angled, ventrocaudal margin of the liver. The umbilical vein is homogeneously hypoechogenic in the umbilical vein sulcus of the liver.

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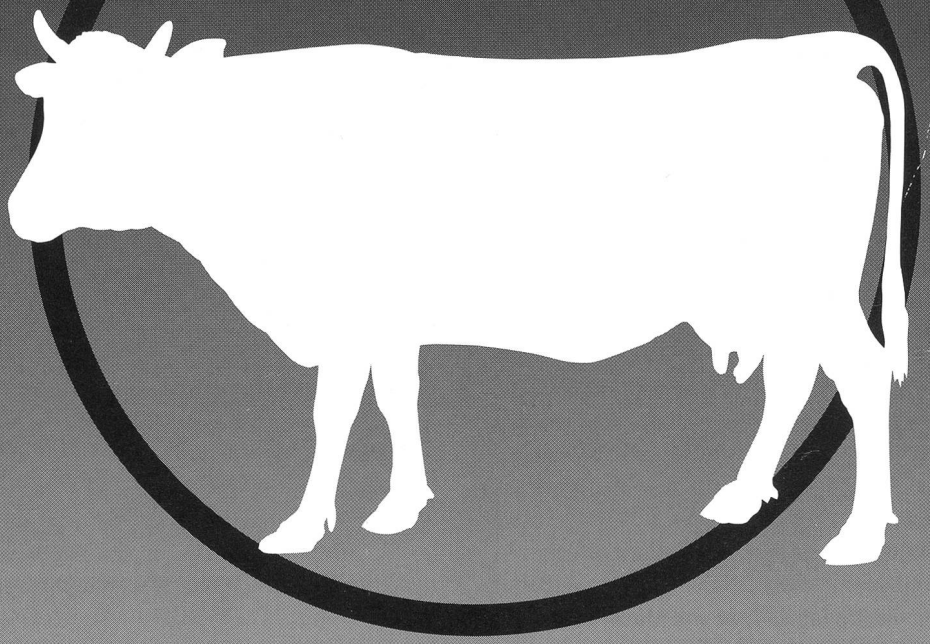

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Anwendung: 2 Injektionen, i.m., am Hals, im Abstand von 14 Tagen geben einen lebenslangen Impfschutz.

Handelsform: Packung zu 2 x 5 Dosen Trockenimpfstoff und 2 x 10 ml Lösungsmittel.

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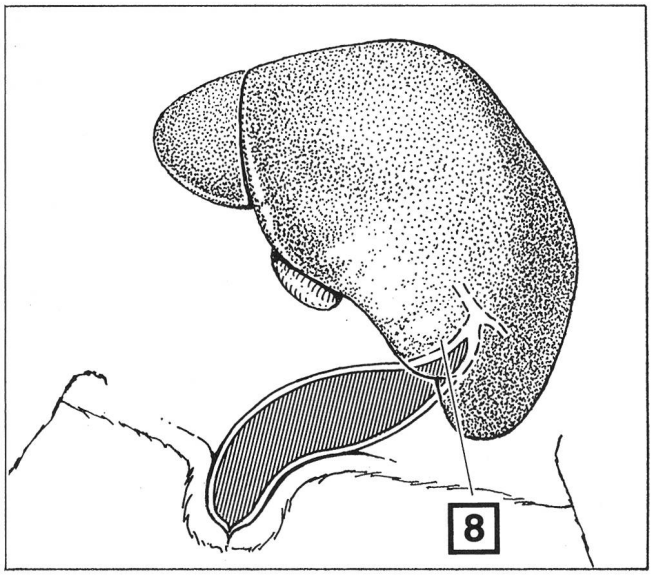
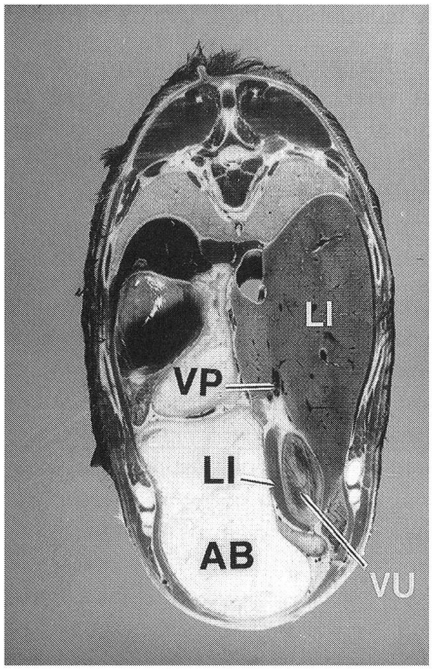
Figure 10: Purulent omphalophlebitis with involvement of the liver in a 7 week old calf



10a: Schematic representation



10b: Frozen section (cross-section; position 8) of the umbilical vein at the same site as figure c. LI: Liver; VP: Vena portae; AB: Abomasum; VU: Vena umbilicalis.

the enlarged umbilical vein was small, identification of the exact extent of the purulent omphalitis was difficult. In these cases, the umbilical vein was carefully filled with isotonic saline solution via the opening of the fistula guided by ultrasound; expansion of the pus-filled lumen in longitudinal section could be clearly viewed at position 7 (fig. 9b).

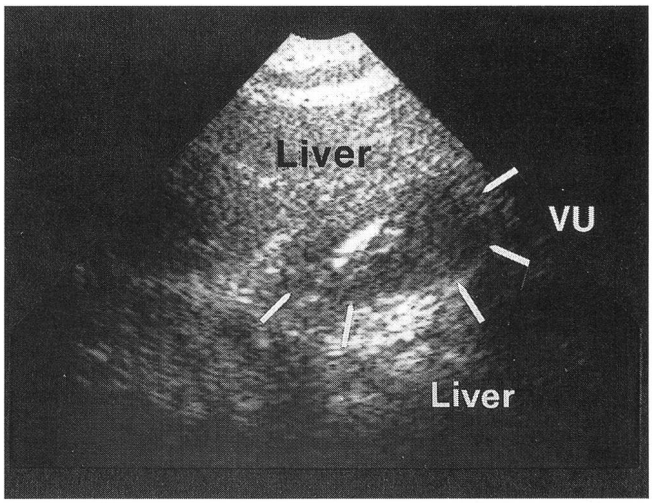
The distance between the abscess and the abdominal wall was very important when assessing umbilical vein abscesses via ultrasonography. In 2 calves with unremarkable extraabdominal umbilici, an intraabdominal abscess was found; these abscesses were situated cranial to the umbilicus, 10 and 12 cm in diameter, and were adhered to the abdominal wall at the length of about 10 cm. The hypoechogenic wall of the abscess could not be differentiated ultrasonographically from the abdominal wall. In both calves, the abscesses were lanced percutaneously under ultrasonographic guidance (fig. 8). A laparotomy was performed when the distance between the lumen of the abscess and the abdominal wall exceeded 3 cm, and when the capsule of the abscess was clearly demarcated from the abdominal wall.

Omphalophlebitis with involvement of the liver (figs. 10):

The enlarged umbilical vein could be imaged within the umbilical vein sulcus of the liver; in cross-section it was completely surrounded by hepatic tissue (position 8; figs. 10b, c).

Omphalophlebitis with liver abcesses (fig. 11):

In 2 calves, multiple, extremely hyperechogenic areas with a diameter of 1 to 3 cm were seen at the junction of the umbilical and portal veins (position 9). Abscess capsules less than 2 mm in width could not be imaged via ultrasonography. The caudoventral margin of the liver of these 2 calves was clearly rounded. As seen in the frozen section, both these calves had multiple liver abscesses (figs. 11a–d).

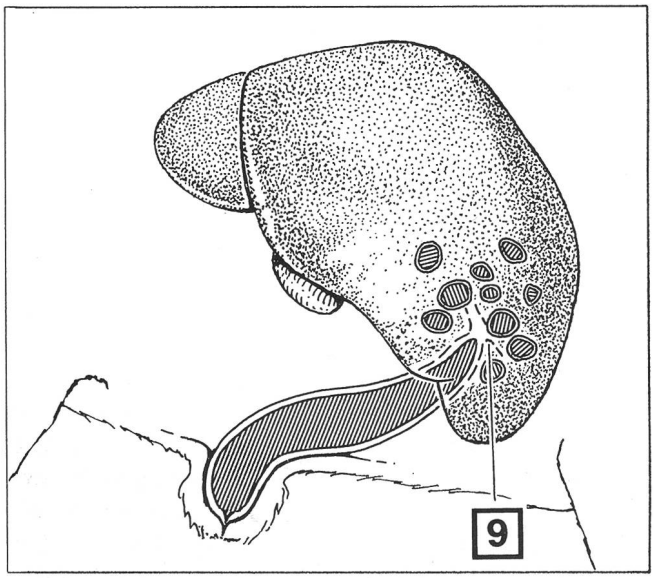


10c: Ultrasonogram (cross-section; position 8; 5 Mhz) of the umbilical vein in the umbilical vein sulcus of the liver. The umbilical vein (VU), viewed slightly obliquely, is completely surrounded by hepatic tissue. The hyperechogenic pus in the lumen of the umbilical vein is clearly demarcated from hepatic tissue by a hypoechogenic capsule.

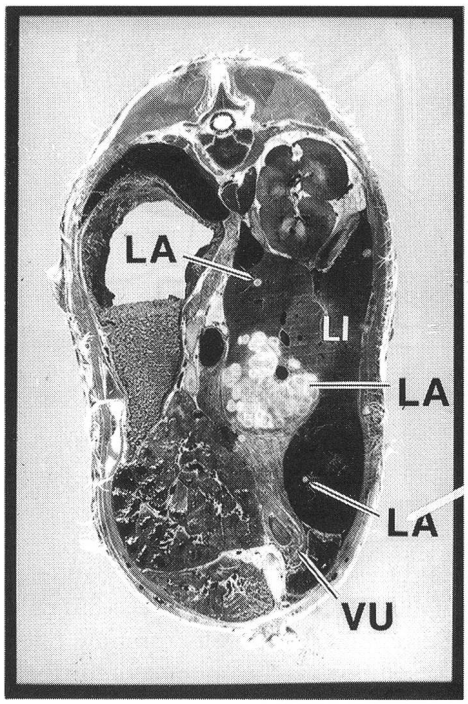
Therapy

10 of 51 calves with inflammation of the intraabdominal umbilical structures were euthanatized. Of these 10 calves, 4 had additional complications such as polyarthritis (1), gonitis (2), and otitis media (1), 2 had liver abscesses as determined by ultrasonography, and 4 had omphalophlebitis with involvement of the liver and the owner opted for euthanasia rather than surgery. In the remaining 41 calves, therapy based on the ultrasonographic diagnosis was performed and was successful in 95% of the cases. Two calves were treated conservatively, and in 3 calves, an intraabdominal abscess was lanced percutaneously and drained. Laparotomy was performed in 36 calves and was unsuccessful in 2 calves; a perforated abomasal ulcer was found during surgery in 1 calf, and the other calf was euthanatized within 7 days after laparotomy because of a meningoencephalitis.

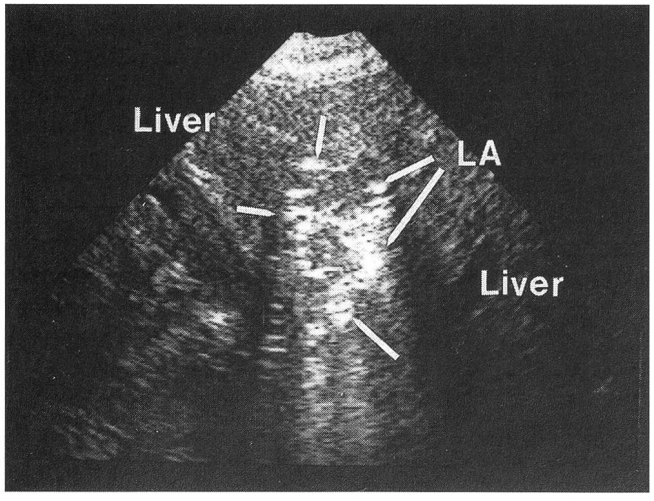
Figure 11: Purulent omphalophlebitis with liver abscesses in a 6 week old calf.



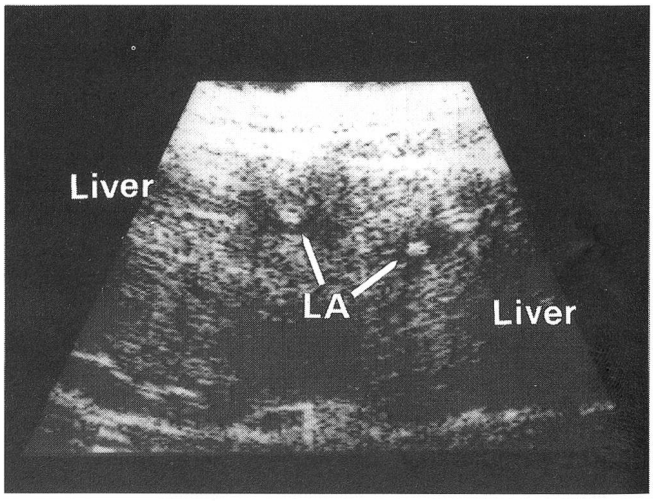
11a: Schematic representation



11b: Frozen section (cross-section; position 9) of the umbilical vein (VU) and the liver (LI) at the same site as figure c. LA: Liver abscess.



11c: Ultrasonogram (cross-section; position 9; 5 Mhz scanner) of multiple abscesses in the liver. Using the 5 Mhz sector scanner, the multiple, thin-walled liver abscesses (LA) appear as single or confluent, hyperechogenic areas in the hepatic tissue. A hypoechogenic capsule is not seen.



11d: Ultrasonogram (cross-section; position 9; 7.5 Mhz scanner) of liver abscesses (LA). Using the 7.5 Mhz sector scanner, a hypoechogenic abscess capsule can be imaged in 2 single liver abscesses (diameter = 10 mm).

Table 5: Ultrasonographic diagnoses of intraabdominal umbilical disease

AFFECTION OF THE URACHUS		**26**
Urachitis without involvement of the urinary bladder		8
Urachitis with involvement of the urinary bladder		16
Patent urachus		2
AFFECTION OF THE UMBILICAL ARTERIES		**19**
Arteriitis without involvement of the urinary bladder		11
Arteriitis with involvement of the urinary bladder		8
AFFECTION OF THE UMBILICAL VEIN		**28**
Phlebitis without involvement of the liver		11
Phlebitis	4	
Purulent phlebitis	4	
Umbilical vein abscess	3	
Phlebitis with involvement of the liver		17
Phlebitis	5	
Purulent phlebitis	6	
Umbilical vein abscess	4	
Liver abscess	2	

Discussion

Palpation is the easiest and most important examination technique for diagnosis of umbilical disease in calves (Rademacher, 1988). Involvement of intraabdominal umbilical structures can be tentatively diagnosed, but the exact extent of umbilical disease can only be determined during surgery or at post mortem examination. Vague findings on abdominal palpation and inability to palpate the tense abdomen of older calves are examples for the limitations of the clinical examination. According to the results of this study, ultrasonography is a very informative and reliable method of examination.

The 7.5 Mhz sector scanner was used primarily for examination of calves less than 6 weeks of age and to assess structures situated directly beneath the skin. The 5 Mhz sector scanner was found to be more suitable for examination of older calves and for visualization of structures larger than 5 cm in diameter.

Ultrasonographic visualization of the contents of enlargement of the extraabdominal umbilicus provided additional information in only a few cases. For example, ultrasonographic assessment of an extraabdominal umbilicus abscess was used to determine whether the abscess could be removed in toto. In addition, ultrasonography was helpful in determining whether the intraabdominal umbilical structures were affected in calves with extraabdominal umbilical disease. Calves up to 3 weeks of age were often presented with mild omphalitis or clinical signs of infectious disease; these calves had been referred to rule-out intraabdominal umbilical disease in its early stage.

Ultrasonography was very useful in diagnosing intraabdominal umbilical disease. Usually, it could be palpated whether enlarged intraabdominal umbilical structures were situated cranially or caudally of the navel; however, the exact extent of the disease could not be determined. In all calves, a reliable pathologic and anatomic diagnosis was possible with the aid of a standardized ultrasonographic examination technique (Lischer, 1991; Lischer and Steiner, 1993). The ultrasonographic diagnoses of intraabdominal umbilical diseases were found to be correct in 100% of the cases.

Pollakiuria and stranguria were the major clinical features in calves with omphaloarteriitis and/or urachitis. Omphaloarteriitis could not be differentiated from urachitis by palpation; however, differentiation was possible in every case by use of ultrasonography. Laparotomy was indicated in all calves with dysuria because the connection between the urinary bladder and the umbilicus had to be resected. The exact size and extent of the intraabdominal umbilical structures could be imaged pre-operatively via ultrasonography. Abscesses exceeding 10 cm in diameter were lanced and rinsed a few days before the surgery (Trent, 1987; Steiner et al., 1990) this made the resection of the affected structures easier and reduced the risk of an accidental abscess-perforation during abdominal surgery. Ultrasonographic examination was also used to determine whether the apex of the urinary bladder required resection as well. In this regard, both the longitudinal and the cross-sectional images of the apex of the bladder were informative. Dripping of urine from the umbilicus is diagnostic for a patent urachus. However, ultrasonography is very suitable for deciding if a patent urachus contained purulent material or not, which is difficult to determine by palpation.

With regard to the choice of the adequate therapeutical procedure, ultrasonography had many advantages, particularly in the diagnosis of omphalophlebitis. Palpation did not reveal whether an enlarged umbilical vein contained purulent material whereas ultrasonography did. Non-purulent phlebitis did not require surgery. In calves with abscesses exceeding 10 cm in diameter and situated completely within the abdominal cavity, ultrasonography was used to determine the optimal site for percutaneous lancing. In calves with omphalophlebitis, it is important to know whether the umbilical vein can be excised easily in one piece or a more involved procedure like partial liver resection (Kaser, 1991) or marsupialization (Steiner et al., 1992) is indicated. Surgery was not advised in 2 calves because multiple liver abscesses were diagnosed.

Additionally, the results of the ultrasonographic examination allowed to determine the most suitable time to perform the surgery. In young calves with acute inflammation of intraabdominal umbilical structures, surgery was delayed until the affected structures were clearly demarcated from the surrounding viscera; this reduced the chance of aggravating an acute peritonitis or of accidentally incising a thin-walled umbilical vessel during surgery.

Ultrasonography is particularly useful in the diagnosis of intraabdominal umbilical disease in calves. Reliable and exact diagnoses require a standardized ultrasonographic examination technique and the knowledge of the physiological process of umbilical involution. The owner can be informed in advance about the optimal age of the calf for a surgical intervention, the expected expense and the prognosis of the planned therapy.

Acknowledgment

Thanks are due to Mr. Mathias Haab for the preparations of the ultrasonograms and the nice schematics drawing.

This project was supported by Ausonics AG, represent by Sonoscan SA, 1752 Villars sur Glâne and Pameda AG Basel, 4142 Münchenstein

References

Aderibigbe A.A. (1986): Management of a navel abscess in a calf. Agri-Practice 7, 34-37.

Angus K., Young G.B. (1972): A note on genetics of umbilical hernia. Vet. Rec. *90,* 245-247.

Baxter G.M. (1989): Umbilical Masses in Calves: Diagnosis, Treatment and Complications. Comp. Cont Educ. - Food animal *11 (4),* 505-513.

Berchtold M., Zaremba W., Grunert E. (1990): Kälberkrankheiten. In: Neugeborenen- und Säuglingskunde der Tiere. Ed. K. Walser and H. Bostedt, Ferdinand Enke Verlag, Stuttgart, 260-335.

Bouckaert J.H., DeMoor A. (1965): Surgical treatment of umbilical infections in calves. Vet. Rec. 77, 771-774.

Brem G., Hondele J., Distl O., Kräusslich H. (1985): Felduntersuchungen über Auftreten und Ursachen von Nabelbrüchen beim Braunvieh. Tierärztl. Umschau *40,* 877-882.

Cheli R. (1968): Le infezioni ombelicali del vitello. Clinica Veterinaria Milano *91,* 141-172.

Ultrasonographie de l'ombilic chez le veau. Partie 2: Sonographie, diagnostique et therapie des maladies ombilicales

Quatre-vingt veaux présentant les symptômes d'une omphalite ont été examinés par palpation et sonographiés avec une sonde sectorielle de 5 Mhz, resp 7,5 Mhz. Les diagnostiques posés à l'aide d'ultrasons ont ensuite été contrôlés pendant l'opération ou après euthanasie. A l'aide de schémas, de préparations anatomiques et de photographies ultrasonographiques, les différentes formes d'omphalites intraabdominales et leur thérapie sont expliquées en détail.
Lors d'excroissances extraabdominales (29 veaux) l'utrasonographie donne des informations complémentaires pour le choix de la thérapie, surtout lors d'hernie qu'on ne peut repositionner ou lors d'abscès ombilicaux.
L'ultrasonographie était particulièrement utile pour la représentation des structures ombilicales intraabdominales. Pour les veaux soufrant d'omphalite on peut rapidement reconnaître ou exclure la participation des structures internes.
Lors d'omphalites intraabdominales (51 veaux) la sonographie a permis une description précise de la grandeur et de l'étendue des structures touchées. En particulier on a pu reconnaître avant l'opération si le foie resp. la vessie étaient touchés.
Dans le cas d'omphalite, la sonographie est un examen complémentaire simple avec une grande sûreté de diagnostic, ce qui facilite le choix de la thérapie. D'autre part le propriétaire peut se faire une idée des chances de succès et du coût de l'opération.

Ultrasonografia delle strutture ombelicali. Parte 2: Sonografia, diagnosi e terapia di malattie ombelicali del vitello

Ottanta vitelli con sintomi clinici di malattia ombelicale sono stati esaminati tramite palpazione e sonografia usando un sector scanner di 5 Mhz e 7,5 Mhz. La diagnosi sonografica e stata confermata durante l'intervento chirurgico o tramite autopsia. Le diverse manifestazioni delle infiammazioni ombelicali e la loro terapia vengono descritte in dettaglio tramite schemi, preparati anatomici e immagini sonografiche.
In 29 vitelli con un ombelico extraaddominale ingrossato l'esame sonografico ha dato ulteriori informazioni sulla scelta della terapia, sopratutto nel caso di ernie non reponibili e ascessi ombelicali. La sonografia e stata particolarmente utile per la rappresentazione delle strutture ombelicali intraaddominali. In vitelli con onfalite si e potuto diagnosticare oppure escludere un coinvolgimento dell'ombelico intraaddominale.
Nel caso di infiammazione intraaddominale dell'ombelico (51 vitelli) la sonografia ha permesso una descrizione dettagliata delle alterazioni delle strutture ombelicali. Sopratutto un coinvolgimento del fegato e della vescica e stato diagnosticato prima dell'intervento chirurgico.
La sonografia si e rivelata un metodo d'analisi semplice e informativo nella diagnosi di malattie ombelicali. Essa facilita la scelta della terapia e la sua sicurezza diagnostca e molto grande. Inoltre il proprietario puo essere informato sin dall'inizio sulla prognosi e sui costi di un intervento chirurgico all'ombelico.

Craig D.R., Kelton D.F, Dietze A.F (1986): Ultrasonographic Diagnosis and Surgical Management of Umbilical Masses in Calves. Proc. 14th World Congress on Diseases of Cattle, *II,* 95–100.

Dirksen G. (1978): Nabelentzündung und Nabelabszess. In: Krankheiten des Rindes. Ed. G. Rosenberger, Paul Parey Verlag, Berlin und Hamburg, 612–614.

Dirksen G., Hofmann W. (1976): Erfahrungen mit der chirurgischen Behandlung aszendierender Nabelinfektionen beim Kalb. Tierärztl. Prax. *4,* 177–184.

Gilman J.P.W., Stringam E.W. (1953): Hereditary umbilical hernia in Holstein cattle. Journal of Hereditary *44,* 113–116.

Hayes H.M. (1974): Congenital umbilical and inguinal hernias in cattle, horses, swines, dogs and cats: Risk by breed and sex among hospital patients. Am. J. Vet. Res. *35,* 839–842.

Hunt J.H., Allen D. (1988): Treatment of patent Urachus associated with congenital imperforate Urethra in a Calf. Cornell Vet. 1989 *(79),* 157–160.

Hylton W.E., Trent A.M. (1989): Congenital urethral obstruction, uroperitonaeum, and omphalitis in a calf. J. Am. Vet. Med. Assoc. *190 (4),* 433–434.

Kaser T. (1991): Diagnose und Therapie der Omphalophlebitis des Kalbes. Proc. Schweizerische Tierärztetage, Sitten, 13–15.

Klein W.R., Firth E.C. (1988): Infection rates in contaminated surgical procedures: A comparison of prophylactic treatment for ond day or four days. Vet. Rec. *123,* 564–566.

Lischer Ch.J. (1991): Sonographische Darstellung der Nabelinvolution beim Kalb. Med. Vet. Dissertation, Zürich.

Lischer Ch.J., Steiner A. (1993): Ultrasonography of umbilicus in calves. Part 1: Ultrasonographic description of umbilical involution in clinically healthy calves. Schweiz. Arch. Tierheilk. *135,* 221–230.

Priester W.A., Glass A.G., Waggoner M.S. (1970): Congenital defects in domestic animals: General consideration. Am. J. Vet. Res. *31,* 1871.

Rademacher G. (1988): Nabelentzündung beim Kalb: Diagnostische Sicherheit der klinischen Untersuchung und ihr prognostischer Wert. Proc. 15th World Congress on Diseases of Cattle, MallorcaI, 55–60.

Steiner A., Baumann D., Flückiger M. (1988): Urachusabszess ohne pathologische Veränderungen des extraabdominalen Nabels bei einem Rind. Tierärztl. Prax. *16,* 33–36.

Steiner A., Flückiger M., Örtle C., Regi G. (1990): Urachuserkrankungen beim Kalb: Klinische und sonographische Befunde sowie Therapie und Prognose. Schweiz. Arch. Tierheilk. *132(4),* 187–195.

Steiner A., Lischer Ch.J., Örtle C. (1992): A modified technique for the marsupialization of umbilical vein abscesses with involvement of the liver in the calf: A review of thirteen cases (1987–1990). Vet. Surg. *3,* 184–189.

Surborg H. (1978): Untersuchungen über die Abstammung von Rindern mit angeborenem Nabelbruch. Dtsch. tierärztl. Wschr. *85,* 113–152.

Trent A.M. (1987): Surgical Management of Umbilical Masses in Calves. Bov. Pract. *22,* 170–173.

Trent A.M., Smith D.F. (1984): Pollakiuria due to urachal abscesses in two heifers. J. Am. Vet. Med. Assoc. *184(8),* 984–986.

Trent A.M., Smith D.F. (1984): Surgical management of umbilical masses with associated umbilical cord remnant infections in calves. J. Am. Vet. Med. Assoc. *185,* 1531–1534.

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Manuskripteingang: 7. Juli 1992